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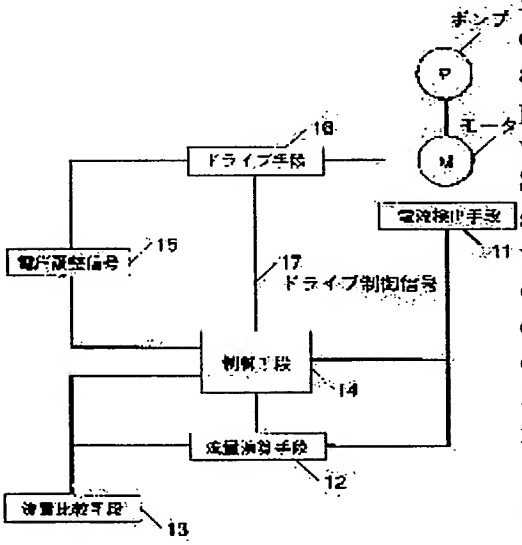
(54) METHOD OF DRIVING AND CONTROLLING DC PUMP



(57)Abstract:
PROBLEM TO BE SOLVED: To provide a method of driving and controlling a DC pump capable of sufficiently assuring a rated flow rate in correspondence with any piping state without necessitating a flow sensor and without consuming wasteful power.
SOLUTION: This DC pump comprises a storage means for storing pump characteristic data obtained when a rated voltage of V0 is applied thereto as the data, a current detection means 11 for detecting a winding current, a flow calculation means 12 for calculating a flow rate by using an output signal from the current detection means 11 and an applied voltage, and a voltage regulating means for regulating the applied voltage so that the flow rate becomes a target flow rate when the pump is installed in a piping system.

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CLAIMS

[Claim(s)]
[Claim 1] [when the pump which makes a DC motor a driving source is installed in the pipe line of arbitration] A storage means to memorize the pump characteristics of the flow rate, the head, and the current at the time of rated voltage V0 impression as data, In order to detect a coil current, have a current detection means, and the output signal of said current detection means and the value of applied voltage are used. Flow rate = It has a flow rate operation means for calculating a flow rate by the formula of the multiplier 1x current + multiplier 2x applied-voltage + multiplier 3. The drive control approach of DC pump characterized by controlling by voltage adjustment means to adjust applied voltage so that it may become the target flow rate with which received the result calculated with said flow rate operation means, and the flow rate was remembered to be by said storage.
[Claim 2] [when the pump which makes a DC motor a driving source is installed in the pipe line of arbitration] A storage means to memorize the pump characteristics of the flow rate, the head, and the current at the time of rated voltage V0 impression as data, In order to detect a coil current, have a current detection means, and the output signal and applied voltage of said current detection means are used. Flow rate = It has a flow rate operation means for calculating a flow rate by the formula of the multiplier 1x current + multiplier 2x applied-voltage + multiplier 3. The drive control approach of DC pump characterized by controlling by current adjustment means to adjust only a current so that it may become the target flow rate with which received the result calculated with said flow rate operation means, and the flow rate was remembered to be by said storage.
[Claim 3] The drive control approach of DC pump according to claim 2 characterized by considering said current adjustment means as PWM control.
[Claim 4] The drive control approach of DC pump according to claim 2 characterized by using said current adjustment means as a demand limiter.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the [redacted]tion]
[0001]
[Field of the Invention] This invention is used for household-electric-appliances devices, such as an air-conditioner and a hot-water supply machine, and relates to the drive control approach of DC pump which makes a driving source DC brushless motor characterized by the capacity adjustable.
[0002]
[Description of the Prior Art] Conventionally, in order to make an AC motor into a driving source, the capacity adjustable of a pump was not made but the capacity of a pump had changed with the frequency of 50/60Hz of a source power supply further, so that it might be represented by the hot-water supply machine in the circulating pump for device nests. Drawing showing the pump characteristics which make a driving source an AC motor [in / for this / the conventional example of drawing 8] explains.
[0003] In drawing 8 , 101 is pump characteristics with a source-power-supply frequency of 50Hz, and 102 is pump characteristics with a source-power-supply frequency of 60Hz. A thing with a pump performance higher than 50Hz has a common way with a source-power-supply frequency of 60Hz so that clearly from this characteristic ray Fig. Moreover, 103 is the operating point of a pump with a source-power-supply frequency [in a certain pipe line] of 60Hz. And 104 is the rated flow Q 0 required as pump capacity, and it being the need with a device nest pump generally is that a rated flow is secured on any piping conditions, and excessive energy is not consumed but it is efficient.
[0004]
[Problem(s) to be Solved by the Invention] If AC pump guarantees the capacity as a pump with the mean value of voltage variation for the voltage variation of the DC power supply which carry out a direct development from the voltage variation of a source power supply, a pump performance will be greatly downed by the lower limit of voltage variation. Moreover, in the case of a centrifugal pump, if the pump built into a device guarantees a pump performance by the lower limit of voltage variation, since power consumption increases so that a flow rate becomes large, power consumption will go up by the upper limit of voltage variation, and a pump will exceed the allowable-temperature conditions of components, such as an electronic device, a substrate, and a coil. That is, with the pump which makes an AC motor a driving source, since it corresponded to the frequency of a piping situation or a source power supply, capacity control needed to be carried out by inverter control etc. Even when the pump which makes a driving source the AC motor which can perform capacity control was furthermore used for JP,59-47155,B like a publication, in order to secure a rated flow, it had the technical problem which needs a flow rate sensor.
[0005] This invention does not need a flow rate sensor etc., but it aims at offering the drive control approach of DC pump of not consuming useless power while it secures the rated flow of a pump the neither more nor less corresponding to all piping situations.
[0006]
[Means for Solving the Problem] [when the pump with which this invention makes a DC motor a driving source is installed in the pipe line of arbitration] A storage means to memorize the pump characteristics of the flow rate, the head, and the current at the time of rated voltage V0 impression as data, In order to detect a coil current, have a current detection means, and the output signal of said current detection means and the value of applied voltage are used. Flow rate = It has a flow rate operation means for calculating a flow rate by the formula of the multiplier 1x current + multiplier 2x applied-voltage + multiplier 3. It is characterized by controlling by voltage adjustment means to adjust applied voltage so that a flow rate may turn into a target flow rate memorized by said storage in response to the result calculated with said flow rate operation means.
[0007] Moreover, when the pump which makes a DC motor a driving source is installed in the pipe line of arbitration, it sets. It has a current detection means for detecting the storage means and coil current which memorize the pump characteristics at the time of rated voltage V0 impression (flow Q, Head H, Current I) as data. And have a flow rate operation means for calculating a flow rate by the aforementioned formula, and the result calculated with said flow rate operation means using the output signal and applied voltage of said current detection means is received. The current in the target flow rate remembered that a flow rate turns into a target flow rate by said storage means is referred to. It corresponds to all piping situations, without needing sensors, such as a flow rate sensor, by considering as the control unit of the pump characterized by controlling by current adjustment means, for example, PWM control, to adjust a current, a current limiter circuit, etc. The rated flow of a pump is secured the neither more nor less, and control which does not consume useless power can be performed.

[0008]
[Embodiment of the Invention] [when the pump with which invention according to claim 1 makes a DC motor a driving source is installed in the pipe line of arbitration] A storage means to memorize the pump characteristics of the flow rate, the head, and the current at the time of rated voltage V0 impression as data, In order to detect a coil current, have a current detection means, and the output signal of said current detection means and the value of applied voltage are used. Flow rate = It has a flow rate operation means for calculating a flow rate by the formula of the multiplier 1x current + multiplier 2x applied-voltage + multiplier 3. It is the drive control approach of DC pump characterized by controlling by voltage adjustment means to adjust applied voltage so that it may become the target flow rate with which received the result calculated with said flow rate operation means, and the flow rate was remembered to be by said storage. While a rated flow is securable from the signal of only a current detection means the neither more nor less by the pipe line of arbitration, it has an operation of being controlled by necessary minimum power consumption.
[0009] [when the pump with which invention according to claim 2 makes a DC motor a driving source is installed in the pipe line of arbitration] A storage means to memorize the pump characteristics of the flow rate, the head, and the current at the time of rated voltage V0 impression as data, In order to detect a coil current, have a current detection means, and the output signal and applied voltage of said current detection means are used. Flow rate = It has a flow rate operation means for calculating a flow rate by the formula of the multiplier 1x current + multiplier 2x applied-voltage + multiplier 3. It is the drive control approach of DC pump characterized by controlling by current adjustment means to adjust only a current so that it may become the target flow rate with which received the result calculated with said flow rate operation means, and the flow rate was remembered to be by said storage. While a rated flow is securable from the signal of only a current detection means the neither more nor less by the pipe line of arbitration, it has an operation that it can control to necessary minimum power consumption.
[0010] It is the drive control approach of DC pump according to claim 2 characterized by invention according to claim 3 considering said current adjustment means as PWM control, and while a rated flow is securable from the signal of only a current detection means the neither more nor less by the pipe line of arbitration, it has an operation that it can control to the power consumption of the source of need min.
[0011] It is the drive control approach of DC pump according to claim 2 characterized by invention according to claim 4 using said current adjustment means as a demand limiter, and while a rated flow is securable from the signal of only a current detection means the neither more nor less by the pipe line of arbitration, it has an operation that it can control to necessary minimum power consumption.
[0012] (Gestalt 1 of operation) The gestalt 1 of operation of this invention is hereafter explained using drawing 1 - drawing 3 .
[0013] Drawing 1 is a block diagram in the gestalt 1 of operation of this invention.
[0014] A current detection means to detect the coil current of the DC motor whose 11 is a driving source in drawing 1 , A flow rate operation means by which 12 calculates the flow rate of a pump with the applied voltage from the output and control means (after-mentioned) of the current detection means 11, The flow rate comparison means in comparison with the flow rate which 13 memorized the rated flow Q 0 of a pump, and was calculated from the flow rate operation means 12, The control means controlled to the rated flow Q 0 from the flow Q 1 which 14 outputted the voltage adjustment signal 15 which adjusts the magnitude of the applied voltage of a motor, and was predicted with the flow rate operation means 12, and 16 are drive means which consist of two or more transistor groups. Moreover, whether a control means's 14 turning on the transistor of the drive means 16 throat which consists of two or more transistor groups which switch the current passed to two or more coils of a motor, and the drive control signal 17 to determine are generated. The drive means 16 inputs the drive control signal 17 and the voltage adjustment signal 15, and compounds and outputs two signals.
[0015] Drawing 2 is drawing showing the pump characteristics of the adjustable capacity in the gestalt 1 of operation of this invention, expresses the pump characteristics when impressing the basic rated voltage V0 with a continuous line in drawing 2 , and expresses the piping pressure loss at the time of a certain flow rate ****** with the broken line. The point A1 expresses flow rate 10 L/min which is a pump rated point at the time of rated voltage 135V impression, 10m of heads, and current 0.74A. Next, when a pump is installed in a certain pipe line, an operating point (flow Q 1, the head H1, current I1) when rated voltage 135V are impressed is set to B1.
[0016] On the other hand, the relation between an electrical potential difference and a current characteristic

is shown as a property shown drawing 2 by the experimental result. And relation between a flow rate, a current, and an electrical potential difference is approximated by the degree type from the property Fig. by this experiment.

[0017]

Flow rate = 222.22x current-0.89x applied voltage ... (1)

Then, a current signal is detected by the current detector for detecting a coil current, and the result and rated flow which calculated the flow rate under the formula (1) in the flow rate arithmetic circuit are measured using the value of the signal and applied voltage. Since there are more flow rates than a rated flow, applied voltage is decreased, and it controls to become rated-flow 10 L/min from an operating point B1. Although the alternate long and short dash line shows the pump characteristics after control, it moves to the operating point C1 (flow rate 10 L/min, 5.8m [of heads], applied-voltage 100V, and current 0.41A) on the line, and a target flow rate can be secured. In addition, drawing showing the experimental result of the relation of the current and electrical potential difference in a gestalt 1, and flow rate of the operation of this invention to drawing 3 is shown.

[0018] (Gestalt 2 of operation) Next, the gestalt 2 of operation of this invention is explained using drawing 4 and drawing 5 .

[0019] Drawing 4 is a block diagram in the gestalt 2 of operation of this invention. In drawing 4 , a current detection means to detect the coil current of the DC motor whose 21 is a driving source, a flow rate operation means by which 22 calculates the flow rate of a pump with the applied-voltage signal from the output and control means (after-mentioned) of the current detection means 21, the flow rate comparison means in comparison with the flow rate which 23 memorized the rated flow Q 0 of a pump, and was calculated from the flow rate operation means 22, and 24 are PWM control means. The PWM control means 24 outputs the current adjustment signal 25 which adjusts the magnitude of the current of a motor. Furthermore, the control means which controls 26 to the rated flow Q 0 from the flow Q 1 predicted with the flow rate operation means 22, and 27 are drive means which consist of two or more transistor groups. The drive control signal 28 which determines whether a control means 26 turns on the transistor of the drive means 27 throat which consists of two or more transistor groups which switch the current passed to two or more coils of a motor is generated. Moreover, the drive means 27 inputs the drive control signal 28 and the current adjustment signal 25, and compounds and outputs two signals.

[0020] Drawing 5 is drawing showing the pump characteristics of the adjustable capacity in the gestalt 2 of operation of this invention, expresses the pump characteristics when impressing the basic rated voltage V0 with a continuous line in drawing 5 , and expresses the piping pressure loss at the time of a certain flow rate ****** with the broken line. The point A2 expresses flow rate 10 L/min which is a pump rated point at the time of rated voltage 135V impression, 10m of heads, and current 0.74A. Next, when a pump is installed in the existing pipe line, let an operating point (flow Q 1, the head H1, current I1) when rated voltage 135V are impressed be B-2. Then, by detecting a current signal by the current detector for detecting a coil current, and measuring the result and rated flow which calculated the flow rate under the above-mentioned formula (1) in the flow rate arithmetic circuit using the value of the signal and applied voltage, since the flow rate is higher than a rated flow With reference to the current in the target flow rate memorized by the storage means, lowering a duty to 50% from 100% by PWM control, i.e., by doubling a current value with numerical 0.45A which acquired the current from the storage means As a result of carrying out control of flow to rated-flow 10 L/min from operating-point B-2, an operating point moves to C2 (flow rate 10 L/min, 5.8m [of heads], applied-voltage 100V, and current 0.41A) as the alternate long and short dash line shows the pump characteristics after control, and a target flow rate can be secured.

[0021] (Gestalt 3 of operation) The gestalt 3 of operation of this invention is explained below using drawing 6 and drawing 7 .

[0022] Drawing 6 is a block diagram in the gestalt 3 of operation of this invention. In drawing 6 , a current detection means to detect the coil current of the DC motor whose 31 is a driving source, a flow rate operation means by which 32 calculates the flow rate of a pump with the applied-voltage signal from the output and control means (after-mentioned) of the current detection means 31, the flow rate comparison means in comparison with the flow rate which 33 memorized the rated flow Q 0 of a pump, and was calculated from the flow rate operation means 32, and 34 are limiter control means. This limiter control means 34 outputs the current adjustment signal 35 which adjusts the current of a pump. Furthermore, the control means which controls 36 to the rated flow Q 0 from the flow Q 1 predicted with the flow rate operation means 32, and 37 are drive means which consist of two or more transistor groups. The drive

control signal 38 which determines whether a control means 36 turns on the transistor of the drive means 37 throat which consists of two or more transistor groups which switch the current passed to two or more coils of a motor is generated. Moreover, the drive means 37 inputs the drive control signal 38 and the current adjustment signal 35, and compounds and outputs two signals.

[0023] Drawing 7 is drawing showing the pump characteristics of the adjustable capacity in the gestalt 3 of operation of this invention, in drawing 7 , when the basic rated voltage V0 is impressed, it expresses pump characteristics with a continuous line, and it expresses the piping pressure loss at the time of a certain flow rate ****** with the broken line. Point A3 expresses flow rate 10 L/min which is a pump rated point at the time of rated voltage 135V impression, 10m of heads, and current 0.74A. Next, when a pump is installed in the existing pipe line, an operating point (flow Q 1, the head H1, rotational frequency N1) when rated voltage 135V are impressed is set to B3. Then, a current signal is detected by the current detector for detecting a coil current, and a flow rate is calculated under the above-mentioned formula (1) in a flow rate arithmetic circuit using the value of the signal and applied voltage. With reference to the current in the target flow rate which measured the result of an operation and rated flow, and was memorized by the storage means since the flow rate was higher than the rated flow, a current is decreased to reference current value 0.45A with a demand limiter. As a result of carrying out control of flow to target flow rate 10 L/min from an operating point B3 by this as the alternate long and short dash line shows the pump characteristics after control, an operating point moves to C3 (flow rate 10 L/min, 6.5m [of heads], applied-voltage 135V, and current 0.45A), and a target flow rate can be secured.

[0024]

[Effect of the Invention] As mentioned above, without carrying out the additional equipment of the sensors, such as a flow rate sensor, specially, by the drive control approach of DC pump of this invention, corresponding to all piping situations, the rated flow of a pump is secured the neither more nor less, and control which does not consume useless power can be performed.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The block diagram in the gestalt 1 of operation of this invention

[Drawing 2] Drawing showing the pump characteristics of the adjustable capacity in the gestalt 1 of operation of this invention

[Drawing 3] Drawing showing the experimental result of the relation of the current and electrical potential difference in a gestalt 1, and flow rate of operation of this invention

[Drawing 4] The block diagram in the gestalt 2 of operation of this invention

[Drawing 5] Drawing showing the pump characteristics of the adjustable capacity in the gestalt 2 of operation of this invention

[Drawing 6] The block diagram in the gestalt 3 of operation of this invention

[Drawing 7] Drawing showing the pump characteristics of the adjustable capacity in the gestalt 3 of operation of this invention

[Drawing 8] Drawing showing the pump characteristics which make the AC motor in the conventional example a driving source

[Description of Notations]

11 Current Detection Means

12 Flow Rate Operation Means

13 Flow Rate Comparison M
14 Control Means
15 Voltage Adjustment Signal
16 Drive Means
17 Drive Control Signal
21 Current Detection Means
22 Flow Rate Operation Means
23 Flow Rate Comparison Means
24 PWM Control Means
25 Current Adjustment Signal
26 Control Means
27 Drive Means
31 Current Detection Means
32 Flow Rate Operation Means
33 Flow Rate Comparison Means
34 Limiter Control Means
35 Current Adjustment Signal
36 Control Means
37 Drive Means
101 Pump Characteristics with a Source-Power-Supply Frequency of 50Hz
102 Pump Characteristics with a Source-Power-Supply Frequency of 60Hz
103 Operating Point of Pump with a Source-Power-Supply Frequency [in a Certain Pipe Line] of 60Hz
104 Rated Flow Q 0 Required as Pump Capacity

[Translation done.]

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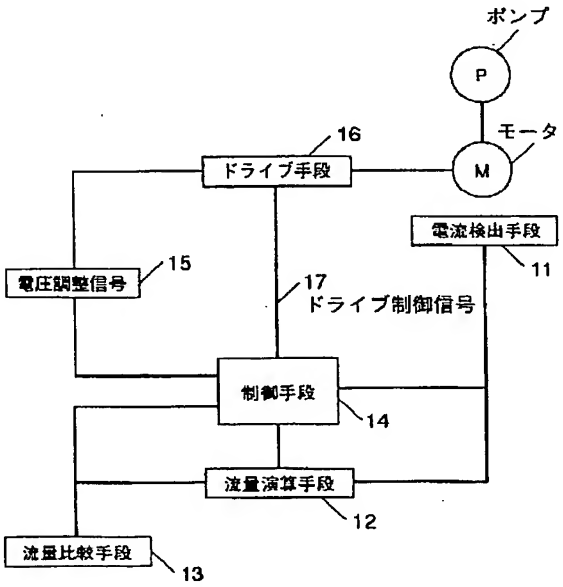
最終頁に続く

(54)【発明の名称】　ＤＣポンプの駆動制御方法

(57)【要約】
【課題】　流量センサ等を必要とせず、あらゆる配管状況に対応してポンプの定格流量を過不足なく確保するとともに無駄な電力を消費しないＤＣポンプの駆動制御方法を提供することを目的とする。
【解決手段】　ＤＣポンプが任意の配管系に設置された場合、定格電圧Ｖ０印加時のポンプ特性をデータとして記憶する記憶手段と、巻線電流を検出するため電流検出手段１１を備え、前記電流検出手段１１の出力信号と印加電圧の値を用い、流量を演算するための流量演算手段１２を備え、流量が目標流量になるように印加電圧を調整する電圧調整手段により制御する。



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【特許請求の範囲】

【請求項１】ＤＣモータを駆動源とするポンプが任意の配管系に設置された場合において、定格電圧Ｖ０印加時の流量と揚程と電流のポンプ特性をデータとして記憶する記憶手段と、巻線電流を検出するため電流検出手段を備え、前記電流検出手段の出力信号と印加電圧の値を用い、流量＝係数１×電流＋係数２×印加電圧＋係数３の式で流量を演算するための流量演算手段を備え、前記流量演算手段で演算された結果を受け、流量が前記記憶装置に記憶された目標流量になるように印加電圧を調整する電圧調整手段により制御することを特徴とするＤＣポンプの駆動制御方法。

【請求項２】ＤＣモータを駆動源とするポンプが任意の配管系に設置された場合において、定格電圧Ｖ０印加時の流量と揚程と電流のポンプ特性をデータとして記憶する記憶手段と、巻線電流を検出するため電流検出手段を備え、前記電流検出手段の出力信号と印加電圧を用い、流量＝係数１×電流＋係数２×印加電圧＋係数３の式で流量を演算するための流量演算手段を備え、前記流量演算手段で演算された結果を受け、流量が前記記憶装置に記憶された目標流量になるように電流のみを調整する電流調整手段により制御することを特徴とするＤＣポンプの駆動制御方法。

【請求項３】前記電流調整手段をＰＷＭ制御とすることを特徴とする請求項２に記載のＤＣポンプの駆動制御方法。

【請求項４】前記電流調整手段を電流リミッターとすることを特徴とする請求項２に記載のＤＣポンプの駆動制御方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、エアコンや給湯機などの家電機器に使用され、能力可変を特徴とするＤＣブラシレスモータを駆動源とするＤＣポンプの駆動制御方法に関するものである。

【０００２】

【従来の技術】機器組込み用の循環ポンプにおいて給湯機に代表されるように、従来はＡＣモータを駆動源とするため、ポンプの能力可変ができず、更に商用電源の周波数５０／６０Ｈｚによってポンプの能力が変わってしまっていた。このことを図８の従来例におけるＡＣモータを駆動源とするポンプ特性を示す図により説明する。

【０００３】図８において、１０１は商用電源周波数５０Ｈｚのポンプ特性で、１０２は商用電源周波数６０Ｈｚのポンプ特性である。この特性線図から明らかなように、商用電源周波数６０Ｈｚのほうが、５０Ｈｚよりポンプ性能が高いのが一般的である。また、１０３はある配管系における商用電源周波数６０Ｈｚのポンプの運転点である。そして、１０４はポンプ能力として必要な定格流量Ｑ０で、一般的に機器組込みポンプで必要なことは、どんな配管条件でも定格流量が確保されることであり、且つ余分なエネルギーを消費せず効率が良いことである。

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【０００４】

【発明が解決しようとする課題】ＡＣポンプは商用電源の電圧変動から直接発生する直流電源の電圧変動のため、ポンプとしての能力を電圧変動の中間値で保証すると電圧変動の下限値でポンプ性能が大きくダウンしてしまう。また、機器に組込まれるポンプは、電圧変動の下限値でポンプ性能を保証すると遠心ポンプの場合では流量が大きくなる程、消費電力が増大するため、電圧変動の上限値で消費電力が上昇し、ポンプは電子素子や基板や巻線等の部品の許容温度条件を超えてしまう。つまり、ＡＣモータを駆動源とするポンプでは、配管状況や商用電源の周波数に対応するために、例えばインバータ制御等により能力制御する必要があった。さらに特公昭５９－４７１５５号公報に記載のように、能力制御ができるＡＣモータを駆動源とするポンプを使用する場合でも、定格流量を確保するため流量センサを必要とする課題を有していた。

【０００５】本発明は、流量センサ等を必要とせず、あらゆる配管状況に対応してポンプの定格流量を過不足なく確保するとともに無駄な電力を消費しないＤＣポンプの駆動制御方法を提供することを目的とする。

【０００６】

【課題を解決するための手段】本発明は、ＤＣモータを駆動源とするポンプが任意の配管系に設置された場合において、定格電圧Ｖ０印加時の流量と揚程と電流のポンプ特性をデータとして記憶する記憶手段と、巻線電流を検出するため電流検出手段を備え、前記電流検出手段の出力信号と印加電圧の値を用い、流量＝係数１×電流＋係数２×印加電圧＋係数３の式で流量を演算するための流量演算手段を備え、前記流量演算手段で演算された結果を受け、流量が前記記憶装置に記憶された目標流量になるように印加電圧を調整する電圧調整手段により制御することを特徴とする。

【０００７】また、ＤＣモータを駆動源とするポンプが任意の配管系に設置された場合において、定格電圧Ｖ０印加時のポンプ特性（流量Ｑ，揚程Ｈ，電流Ｉ）をデータとして記憶する記憶手段と巻線電流を検出するための電流検出手段を備え、且つ前記の式で流量を演算するための流量演算手段を備え、前記電流検出手段の出力信号と印加電圧を用い前記流量演算手段で演算された結果を受け、流量が目標流量になるように前記記憶手段に記憶された目標流量における電流を参照し、電流を調整する電流調整手段、例えばＰＷＭ制御、電流リミッター回路等により制御することを特徴とするポンプの制御装置とすることによって流量センサ等のセンサを必要とせずに、あらゆる配管状況に対応して、ポンプの定格流量を過不足なく確保し、無駄な電力を消費しない制御ができ

る。

【０００８】

【発明の実施の形態】請求項１に記載の発明は、ＤＣモータを駆動源とするポンプが任意の配管系に設置された場合において、定格電圧Ｖ０印加時の流量と揚程と電流のポンプ特性をデータとして記憶する記憶手段と、巻線電流を検出するため電流検出手段を備え、前記電流検出手段の出力信号と印加電圧の値を用い、流量＝係数１×電流＋係数２×印加電圧＋係数３の式で流量を演算するための流量演算手段を備え、前記流量演算手段で演算された結果を受け、流量が前記記憶装置に記憶された目標流量になるように印加電圧を調整する電圧調整手段により制御することを特徴とするＤＣポンプの駆動制御方法であり、電流検出手段のみの信号から任意の配管系で定格流量を過不足なく確保できると共に、必要最小限の消費電力に抑制されるという作用を有する。

【０００９】請求項２に記載の発明は、ＤＣモータを駆動源とするポンプが任意の配管系に設置された場合において、定格電圧Ｖ０印加時の流量と揚程と電流のポンプ特性をデータとして記憶する記憶手段と、巻線電流を検出するため電流検出手段を備え、前記電流検出手段の出力信号と印加電圧を用い、流量＝係数１×電流＋係数２×印加電圧＋係数３の式で流量を演算するための流量演算手段を備え、前記流量演算手段で演算された結果を受け、流量が前記記憶装置に記憶された目標流量になるように電流のみを調整する電流調整手段により制御することを特徴とするＤＣポンプの駆動制御方法であり、電流検出手段のみの信号から任意の配管系で定格流量を過不足なく確保できると共に、必要最小限の消費電力に抑制できるという作用を有する。

【００１０】請求項３に記載の発明は、前記電流調整手段をＰＷＭ制御とすることを特徴とする請求項２に記載のＤＣポンプの駆動制御方法であり、電流検出手段のみの信号から任意の配管系で定格流量を過不足なく確保できるとともに、必要最小源の消費電力に抑制できるという作用を有する。

【００１１】請求項４に記載の発明は、前記電流調整手段を電流リミッターとすることを特徴とする請求項２に＊記載のＤＣポンプの駆動制御方法であり、電流検出手段のみの信号から任意の配管系で定格流量を過不足なく確保できると共に、必要最小限の消費電力に抑制できるという作用を有する。

【００１２】（実施の形態１）以下、本発明の実施の形態１について図１～図３を用いて説明する。

【００１３】図１は本発明の実施の形態１におけるブロック図である。

【００１４】図１において、１１は駆動源であるＤＣモータの巻線電流を検出する電流検出手段、１２は電流検出手段１１の出力及び制御手段（後述）からの印加電圧によりポンプの流量を算定する流量演算手段、１３はポンプの定格流量Ｑ０を記憶し流量演算手段１２より算定した流量と比較する流量比較手段、１４はモータの印加電圧の大きさを調整する電圧調整信号１５を出力し流量演算手段１２で予測された流量Ｑ１から定格流量Ｑ０に制御する制御手段、１６は複数のトランジスタ群で構成されるドライブ手段である。また、制御手段１４はモータの複数の巻線に流す電流を切り換える複数のトランジスタ群で構成されるドライブ手段１６のどのトランジスタをオンするか決定するドライブ制御信号１７を生成する。ドライブ手段１６はドライブ制御信号１７と電圧調整信号１５を入力し、２つの信号を合成して出力する。

【００１５】図２は本発明の実施の形態１における可変能力のポンプ特性を示す図であり、図２において、基本となる定格電圧Ｖ０を印加したときのポンプ特性を実線で表し、ある流量流れた時の配管圧力損失を破線で表している。ポイントＡ１は定格電圧１３５Ｖ印加時のポンプ定格点である流量１０Ｌ／ｍｉｎ，揚程１０ｍ，電流０．７４Ａを表している。次に、ある配管系にポンプが設置された場合、定格電圧１３５Ｖが印加された時の運転点（流量Ｑ１，揚程Ｈ１，電流Ｉ１）をＢ１とする。

【００１６】一方、電圧と電流特性の関係は実験結果により図２に示す特性として示される。そして、この実験による特性図から、流量と電流及び電圧との関係は次式で近似される。

【００１７】

流量＝２２２．２２×電流－０．８９×印加電圧・・・（１）

そこで、巻線電流を検出するための電流検出回路により電流信号を検知し、その信号と印加電圧の値を用い、流量を流量演算回路において式（１）の下に演算した結果と定格流量を比較する。流量が定格流量より多いので印加電圧を減少させて、運転点Ｂ１から定格流量１０Ｌ／ｍｉｎになるように制御する。制御後のポンプ特性を一点鎖線で示しているが、その線上の運転点Ｃ１（流量１０Ｌ／ｍｉｎ，揚程５．８ｍ，印加電圧１００Ｖ，電流０．４１Ａ）に移動し、目標流量を確保できる。なお、図３に本発明の実施の形態１における電流と電圧と流量の関係の実験結果を示す図を示す。

【００１８】（実施の形態２）次に、本発明の実施の形態２について図４及び図５を用いて説明する。

【００１９】図４は本発明の実施の形態２におけるブロック図である。図４において、２１は駆動源であるＤＣモータの巻線電流を検出する電流検出手段、２２は電流検出手段２１の出力及び制御手段（後述）からの印加電圧信号によりポンプの流量を算定する流量演算手段、２３はポンプの定格流量Ｑ０を記憶し流量演算手段２２より算定した流量と比較する流量比較手段、２４はＰＷＭ制御手段である。ＰＷＭ制御手段２４は、モータの電流の大きさを調整する電流調整信号２５を出力する。さら

に、２６は流量演算手段２２で予測された流量Ｑ１から定格流量Ｑ０に制御する制御手段、２７は複数のトランジスタ群で構成されるドライブ手段である。制御手段２６はモータの複数の巻線に流す電流を切り換える複数のトランジスタ群で構成されるドライブ手段２７のどのトランジスタをオンするかを決定するドライブ制御信号２８を生成する。また、ドライブ手段２７はドライブ制御信号２８と電流調整信号２５を入力し、２つの信号を合成して出力する。

【００２０】図５は本発明の実施の形態２における可変能力のポンプ特性を示す図で、図５において、基本となる定格電圧Ｖ０を印加した時のポンプ特性を実線で表し、ある流量流れた時の配管圧力損失を破線で表している。ポイントＡ２は定格電圧１３５Ｖ印加時のポンプ定格点である流量１０Ｌ／ｍｉｎ，揚程１０ｍ，電流０．７４Ａを表している。次にある配管系にポンプが設置された場合、定格電圧１３５Ｖが印加された時の運転点（流量Ｑ１，揚程Ｈ１，電流Ｉ１）をＢ２とする。そこで巻線電流を検出するための電流検出回路により電流信号を検知し、その信号と印加電圧の値を用い、流量を流量演算回路で上記の式（１）の下に演算した結果と定格流量を比較して流量が定格流量より高いので、記憶手段に記憶された目標流量における電流を参照し、ＰＷＭ制御によりデュティを１００％から５０％に下げること、つまり電流を記憶手段から得た数値０．４５Ａに電流値を合せることによって、運転点Ｂ２から定格流量１０Ｌ／ｍｉｎに流量制御した結果、制御後のポンプ特性を一点鎖線で示しているように運転点がＣ２（流量１０Ｌ／ｍｉｎ，揚程５．８ｍ，印加電圧１００Ｖ，電流０．４１Ａ）に移動し、目標流量を確保できる。

【００２１】（実施の形態３）次に本発明の実施の形態３について図６及び図７を用いて説明する。

【００２２】図６は本発明の実施の形態３におけるブロック図である。図６において、３１は駆動源であるＤＣモータの巻線電流を検出する電流検出手段、３２は電流検出手段３１の出力及び制御手段（後述）からの印加電圧信号によりポンプの流量を算定する流量演算手段、３３はポンプの定格流量Ｑ０を記憶し流量演算手段３２より算定した流量と比較する流量比較手段、３４はリミッタ制御手段である。このリミッタ制御手段３４はポンプの電流を調整する電流調整信号３５を出力する。さらに、３６は流量演算手段３２で予測された流量Ｑ１から定格流量Ｑ０に制御する制御手段、３７は複数のトランジスタ群で構成されるドライブ手段である。制御手段３６はモータの複数の巻線に流す電流を切り換える複数のトランジスタ群で構成されるドライブ手段３７のどのトランジスタをオンするかを決定するドライブ制御信号３８を生成する。また、ドライブ手段３７はドライブ制御信号３８と電流調整信号３５を入力し、２つの信号を合成して出力する。

【００２３】図７は本発明の実施の形態３における可変能力のポンプ特性を示す図で、図７において、基本となる定格電圧Ｖ０を印加したときポンプ特性を実線で表し、ある流量流れた時の配管圧力損失を破線で表している。ポイントＡ３は定格電圧１３５Ｖ印加時のポンプ定格点である流量１０Ｌ／ｍｉｎ，揚程１０ｍ，電流０．７４Ａを表している。次にある配管系にポンプが設置された場合、定格電圧１３５Ｖが印加された時の運転点（流量Ｑ１，揚程Ｈ１，回転数Ｎ１）をＢ３とする。そこで巻線電流を検出するための電流検出回路により電流信号を検知し、その信号と印加電圧の値を用い、流量を流量演算回路で上記の式（１）の下に演算する。その演算結果と定格流量を比較して流量が定格流量より高いので、記憶手段に記憶された目標流量における電流を参照し、電流リミッターにより電流を参照電流値０．４５Ａに減少させる。これにより、制御後のポンプ特性を一点鎖線で示しているように運転点Ｂ３から目標流量１０Ｌ／ｍｉｎに流量制御した結果、運転点がＣ３（流量１０Ｌ／ｍｉｎ，揚程６．５ｍ，印加電圧１３５Ｖ，電流０．４５Ａ）に移動し、目標流量を確保できる。

【００２４】

【発明の効果】以上のように本発明のＤＣポンプの駆動制御方法では、流量センサ等のセンサをわざわざ追加装備せずに、あらゆる配管状況に対応して、ポンプの定格流量を過不足なく確保し、無駄な電力を消費しない制御ができる。

【図面の簡単な説明】

【図１】本発明の実施の形態１におけるブロック図

【図２】本発明の実施の形態１における可変能力のポンプ特性を示す図

【図３】本発明の実施の形態１における電流と電圧と流量の関係の実験結果を示す図

【図４】本発明の実施の形態２におけるブロック図

【図５】本発明の実施の形態２における可変能力のポンプ特性を示す図

【図６】本発明の実施の形態３におけるブロック図

【図７】本発明の実施の形態３における可変能力のポンプ特性を示す図

【図８】従来例におけるＡＣモータを駆動源とするポンプ特性を示す図

【符号の説明】

１１　電流検出手段
１２　流量演算手段
１３　流量比較手段
１４　制御手段
１５　電圧調整信号
１６　ドライブ手段
１７　ドライブ制御信号
２１　電流検出手段
２２　流量演算手段

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２３　流量比較手段
２４　ＰＷＭ制御手段
２５　電流調整信号
２６　制御手段
２７　ドライブ手段
３１　電流検出手段
３２　流量演算手段
３３　流量比較手段
３４　リミッタ制御手段

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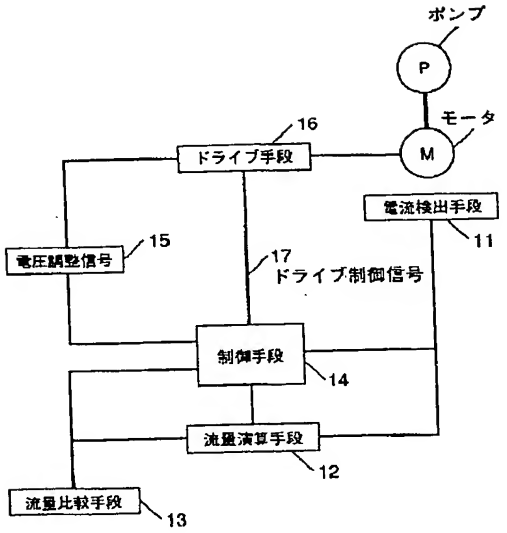
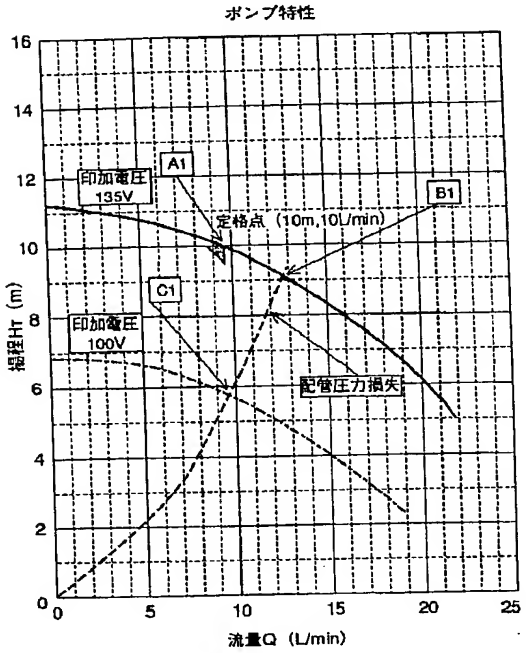
＊３５　電流調整信号
３６　制御手段
３７　ドライブ手段
１０１　商用電源周波数５０Ｈｚのポンプ特性
１０２　商用電源周波数６０Ｈｚのポンプ特性
１０３　ある配管系における商用電源周波数６０Ｈｚのポンプの運転点
１０４　ポンプ能力として必要な定格流量Ｑ０

＊

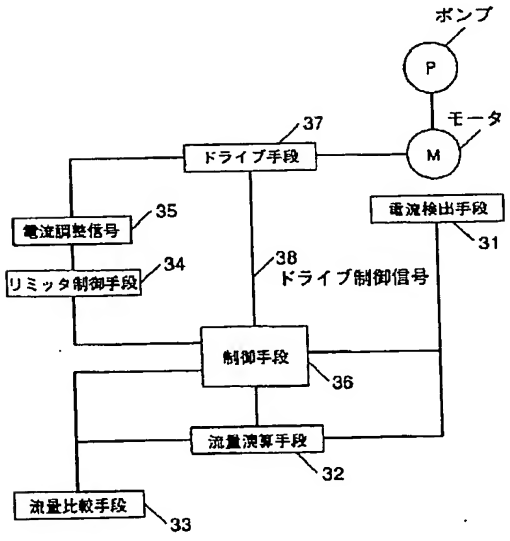
【図１】



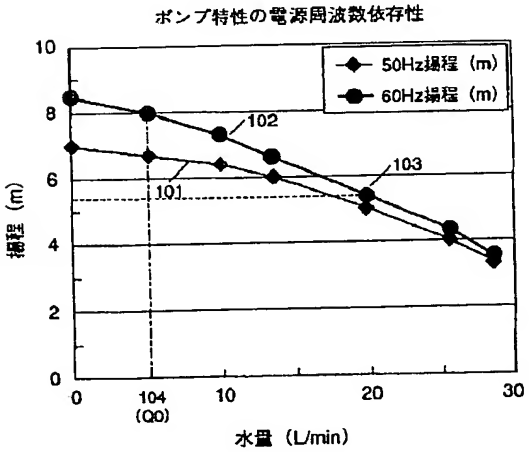
【図２】



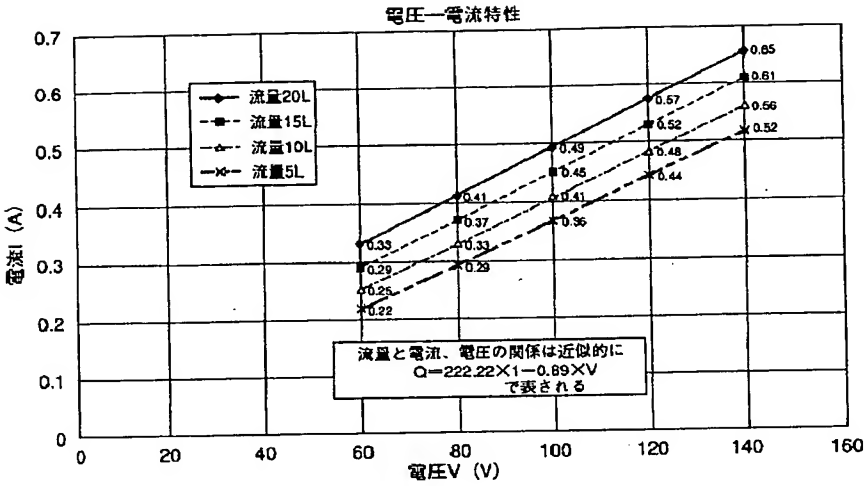
【図６】



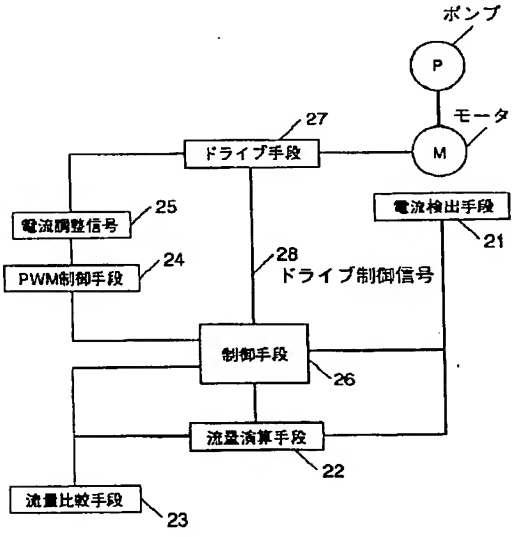
【図８】



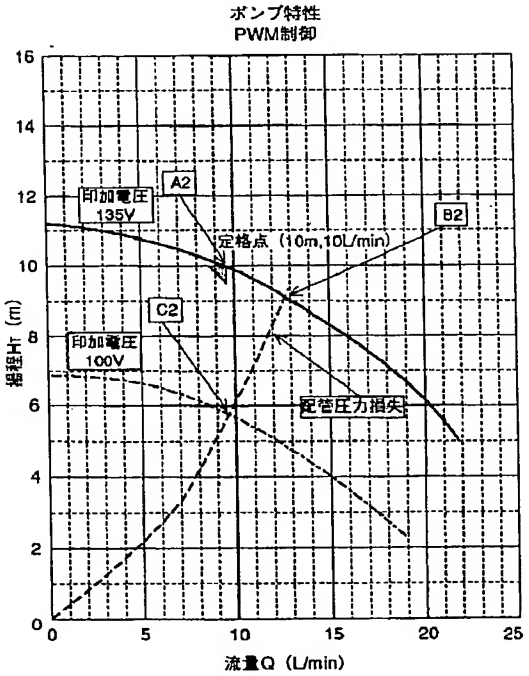
【図３】


電圧—電流特性
流量20L
流量15L
流量10L
流量5L
流量と電流、電圧の関係は近似的に
Q=222.22×I−0.89×V
で表される
電流I（A）
電圧V（V）

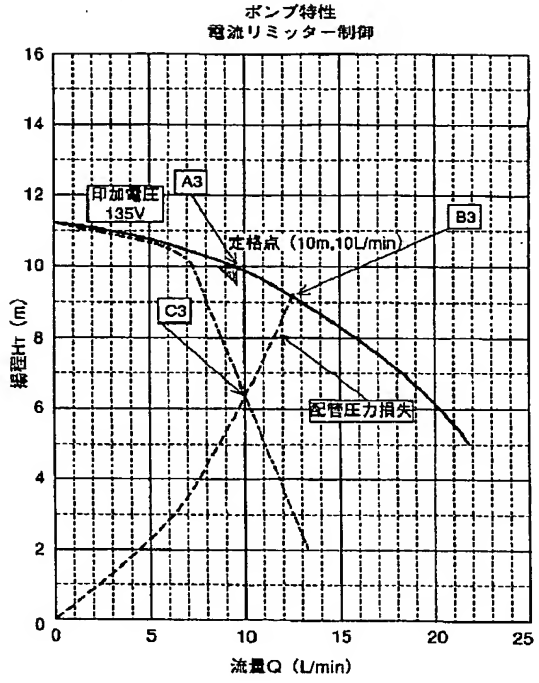
【図４】


ポンプ
P
モータ
M
27
ドライブ手段
電流検出手段
21
電流調整信号
25
PWM制御手段
24
28
ドライブ制御信号
制御手段
26
流量演算手段
22
流量比較手段
23

【図５】


ポンプ特性
PWM制御
印加電圧
135V
A2
B2
定格点（10m,10L/min）
C2
印加電圧
100V
定管圧力損失
揚程Ht（m）
流量Q（L/min）

【図７】



フロントページの続き

Ｆターム(参考)　3H020 AA01 BA06 BA12 BA18 CA04
CA08 DA04 EA10 EA11
3H045 AA05 AA09 AA12 AA23 AA27
BA13 CA21 DA08
5H571 AA11 BB02 BB03 GG04 HA08
HD02 LL22 MM02 MM04